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Iowa's Forest Resources in 1999

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ABSTRACT.—The North Central Research Station's Forest Inventory and Analysis Program began fieldwork for the fourth forest inventory of Iowa in 1999. This inventory initiates a new annual inventory system. This Research Note contains preliminary estimates of Iowa's forest resources prepared from data gathered during the first year of the inventory.

KEY WORDS: Annual inventory, forest land, forest type, growing-stock volume, Iowa.

BACKGROUND

The North Central Research Station's Forest Inventory and Analysis Program (NCFIA) began fieldwork for the fourth forest inventory of Iowa in 1999, in cooperation with the Iowa Department of Natural Resources. This inventory initiates a new annual inventory system. Under this new system, one-fifth of the field plots in the State are measured each year. As a result, the current inventory of Iowa's forest resources will not be completed until 2004. However, because each year's sample is a systematic sample of the State's forests and because timely information is needed about Iowa's forest resources, preliminary estimates of Iowa's forest resources have been prepared from data gathered during the first year of the inventory. **Due to the limited number of field plots measured, future estimates using data in this report are subject to change when ensuing annual inventories are completed and data compiled.** The results presented are estimates based on sampling techniques. As additional annual inventories are completed, the precision of the estimates will increase and additional data will be released.

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Reports of previous inventories of Iowa are dated 1954, 1974, and 1990. Data from new inventories are often compared with data from earlier inventories to determine trends in forest resources. However, for the comparisons to be valid, the procedures used in the two inventories must be similar. As a result of our ongoing efforts to improve the efficiency and reliability of the inventory, several changes in procedures and definitions have been made since the last Iowa inventory in 1990. Some of these changes make it inappropriate to directly compare portions of the 1999 data with those published for 1990. When comparisons are made or estimates presented from past inventories in this report, data from previous inventories are recomputed using current methods to ensure that comparisons are valid.

RESULTS

Iowa, known for its prairie landscapes and agricultural-based economy, also has a relatively small but very valuable forest resource. The original land survey of Iowa, conducted from 1832 to 1859, estimated that Iowa had 7 million acres of forest land. A century later, in 1954, the USDA Forest Service performed its first periodic inventory of Iowa and found that the State had an estimated 2.4 million acres of forest land. The loss of forest area between the surveys was caused by land settlement, agricultural policies and practices, and mechanization of farming equipment. These practices and policies helped Iowa become one of the Nation's top agricultural producing States. Iowa's forest land declined by an average of 46,000 acres per year from the time of the original land survey until the end of the 1954 inventory and it declined by an average of 35,000 acres per year from 1954 to 1974. But Iowa's forest land gained an average of 31,000 acres per year from 1974 to 1990 (Thorton and Morgan 1959, Spencer and Jakes 1979, Brand and Walkowiak 1991, Leatherberry *et al.* 1992).

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Results of the 1999 inventory of Iowa show a slight decrease in the area of forest land (fig. 1). It appears that in the 10 years between inventories (1989 to 1999), the area of forest land in the State decreased by approximately 5 percent. Timberland, a subset of forest land, followed the same trend in Iowa. (Timberland is forest land that is capable of growing trees at a minimum level (20 cubic feet per acre per year) and that is not restricted from harvesting.)

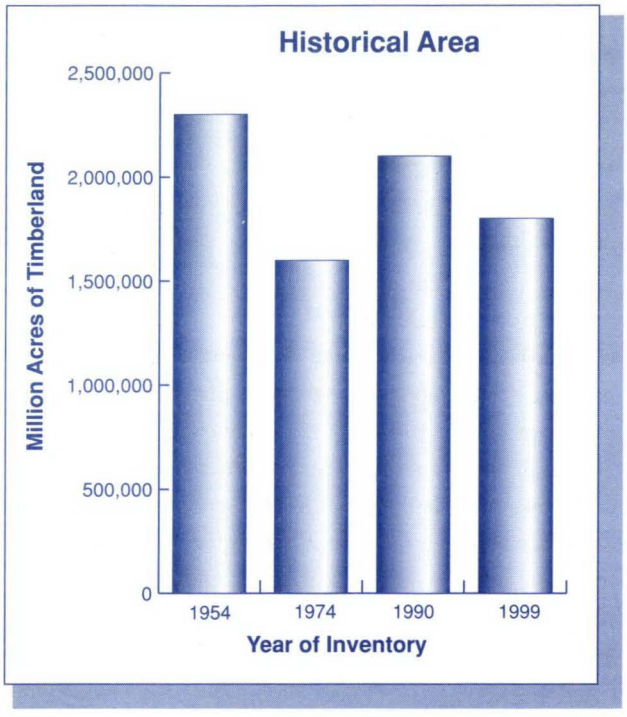
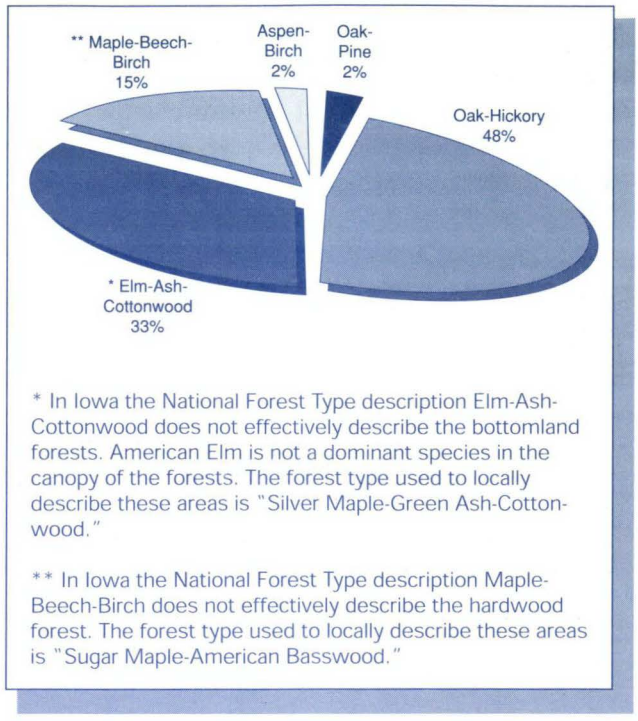


Figure 1.—*Area of timberland in Iowa by inventory year.*

As in the three previous inventories, oak forests dominated the timberlands of Iowa in the 1999 inventory; almost 48 percent of the timberland in Iowa was classified as oak-hickory forest type (fig. 2). Publicly owned forest land in Iowa increased by 24 percent between 1990 and 1999. Publicly owned timberlands are important because they are major sources of wildlife habitat, outdoor recreation, and other social and environmental benefits. On average, public forest land appears to have better stocking rates (stocking is a measure of the density of tree cover) and more volume per acre than most privately owned timberlands in Iowa.

As timberlands continue to mature, area in sapling-seedling size stands continues to decrease (fig. 3). Between 1989 and 1999, sawtimber-sized stands decreased slightly in total area and poletimber-sized stands increased in total area by 23 percent. Forests in the State have been maturing due to a lack of natural or human disturbances. The number of



* In Iowa the National Forest Type description Elm-Ash-Cottonwood does not effectively describe the bottomland forests. American Elm is not a dominant species in the canopy of the forests. The forest type used to locally describe these areas is "Silver Maple-Green Ash-Cottonwood."

** In Iowa the National Forest Type description Maple-Beech-Birch does not effectively describe the hardwood forest. The forest type used to locally describe these areas is "Sugar Maple-American Basswood."

Figure 2.—*Area of timberland in Iowa by forest type, 1999.*

disturbances from fire has declined in Iowa over time. Historically, harvesting methods in Iowa have focused on individual tree selection (individual trees were selected for harvest, but the entire stand was not removed). This harvesting method generally does not result in a change in stand-size classification. As a result, we anticipate that Iowa's future forests will continue to be dominated by pole- and sawtimber-sized stands.

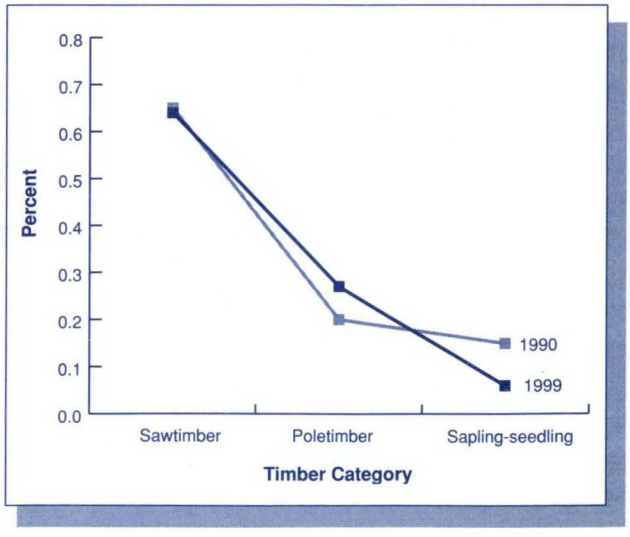


Figure 3.—*Stand-size classification as a percentage of* total timberland area in Iowa, 1990 and 1999.

With the increase in average stand-size class, growing-stock volume has also increased. (Growing-stock volume is the amount of solid wood in trees 5 inches d.b.h. and over, from 1 foot above ground to a minimum 4-inch top diameter.) As trees increase in diameter and as the timberlands increase their stocking rate, the volume of wood also increases (figs. 4, 5). Another factor in the increase of growing-stock volume between inventories is the conversion of some non-growing stock (primarily having rough form) to growing stock because of improved quality.

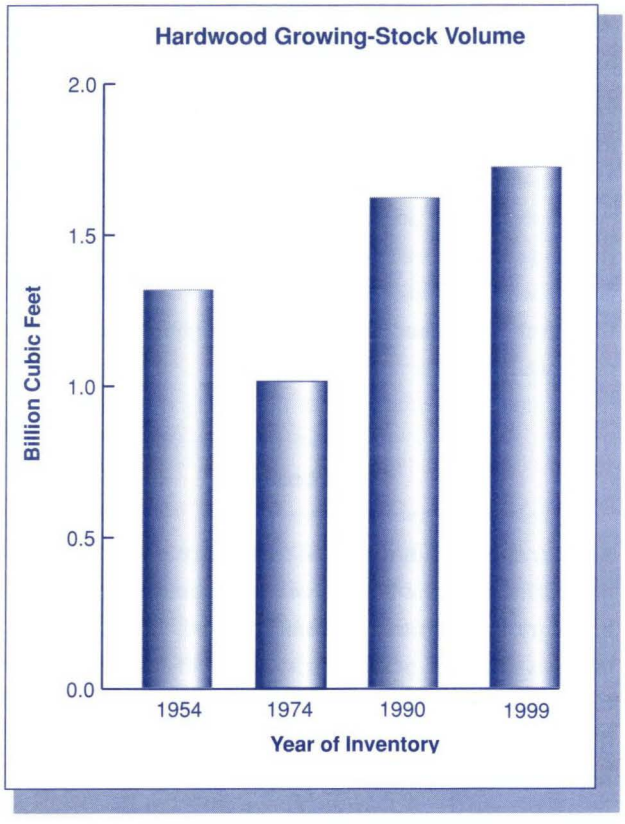


Figure 4.—*Hardwood growing-stock volume in Iowa by inventory year.*

In 1999, the majority of the growing-stock volume in Iowa was in the oak species. The second greatest volumes were in cottonwood species, followed by maples, elm, hickory, black walnut, and hackberry. Hardwoods dominated in Iowa in 1999, representing more than 95 percent of the total growing-stock volume.

In summary, the initial annual inventory of Iowa completed in 1999 shows that despite a potential decrease in total area,

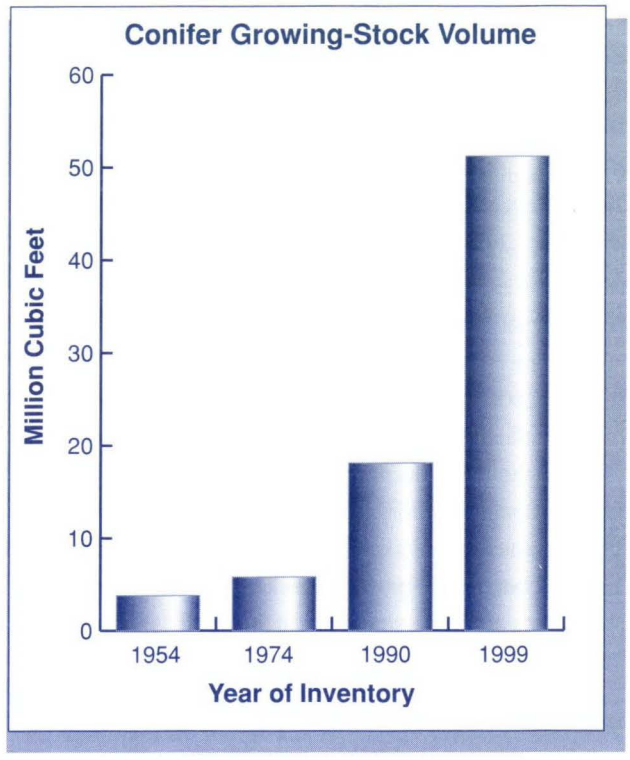


Figure 5.—*Conifer growing-stock volume in Iowa by inventory year.*

increases are occurring in stocking, growing-stock volumes, and most other measures related to forest land and timberland. This is a positive note for the condition of the State's forests as we await further implementation and completion of additional annual inventories in Iowa.

INVENTORY METHODS

Changes Between Inventories

Since the 1990 inventory of Iowa, several changes have been made in NCFIA inventory methods to improve the quality of the inventory as well as to meet increasing demands for timely forest resource information. The most significant difference between inventories was the change from periodic inventories to annual inventories. Historically, NCFIA periodically inventoried each State on a cycle that averaged about 15 years. However, the need for timely and consistent data across large geographical regions, combined with national legislative mandates, resulted in NCFIA's implementation of an annual inventory system. Iowa was one of the

first States in the North Central region, and one of the first States in the Nation, to be inventoried with this new system, beginning with the 1999 inventory.

With an annual inventory system, about one-fifth of all field plots are measured each year. After 5 years, the entire inventory will be completed. After the first 5 years, NCFIA will report and analyze results as a 5-year moving average. For example, NCFIA will be able to generate a report based on inventory results for 1999 through 2004 or for 2001 through 2006. While there are great advantages in an annual inventory, one difficulty is reporting on results in the first 4 years. In the 1999 inventory of Iowa, only 20 percent of the field plots were measured. Sampling error estimates for the 1999 inventory results are 7.9 percent for timberland area and 12.2 percent for growing-stock volume. Thus, caution should be used when drawing conclusions based on this limited data set. As ensuing measurements are completed, we will have additional confidence in our results due to the increased number of field plots measured. As each measurement year is completed, the quantity and quality of results will increase.

Other significant changes between inventories include the implementation of new remote sensing technology, implementation of a new field plot design, development of new volume equations, and gathering of additional remotely sensed and field data.

Remote Sensing Techniques

The advent of remote sensing technology since the previous inventory in 1990 allowed NCFIA to use computer-assisted classifications of Multi-Resolution Land Characterization (MRLC) data and other available remote sensing products to stratify the total area of the State and to improve estimates. Previous inventories used manual interpretation of aerial photos to stratify the sample.

New Volume Equations

The new volume equations, developed by USDA Forest Service research scientists and other cooperating researchers, more accurately estimate growing-stock and sawtimber volumes. As additional annual inventories are implemented and comparisons between the current inventory and previous inventories become possible, FIA will produce new estimates from the 1990 inventory using the new volume tables to allow a comparison with the 1999 inventory results.

Forest Type and Stand Size

New algorithms were used in 1999 to assign forest type and stand-size class to each condition observed on a plot. These algorithms are being used nationwide by FIA to provide consistency from State to State and will be used to reassign the forest type and stand-size class of every plot measured in the 1990 inventory. This will be done so that changes in forest type and stand-size class will reflect actual changes in the forest and not changes due to a change in algorithms. The list of recognized forest types, grouping of these forest types for reporting purposes, equations used to assign stocking values to individual trees, definition of nonstocked (stands with a stocking value of less than 10 percent for all live trees), and names given to the forest types changed with the new algorithms.

Plot Location

Another change with the current inventory is the determination of the exact plot location of every ground plot in the inventory. For plots that are visited in the field, this is done using a geographic positioning system (GPS) device at plot center. For plots not visited in the field, the plot location is determined by transferring the old plot location from the aerial photography to an unclassified, geo-corrected remotely sensed image. Both procedures provide an accurate location that is used to link the ground plots to the classified remotely sensed data used for stratification.

PROCEDURES

The 1999 Iowa survey used a two-phase sample for stratification that included re-measuring inventory plots from the 1990 inventory and new field plots. Two-phase sampling, also called double sampling, consists of a phase-one sample used to estimate area by strata and a phase-two sample used to estimate the average value of parameters of interest within these strata. The estimated population total is the sum across all strata of each stratum's estimated area multiplied by its estimated mean per unit area.

The only land that could not be sampled was private land where field personnel could not obtain permission from the owner to measure a phase-two field plot. These denied access plots were somewhat rare in Iowa (less than 1 percent of the total forest plots statewide), and the methods used in the preparation of this report make the necessary adjustments to account for sites where access was denied.

Phase One

Phase-one and phase-two plots were placed systematically across the entire State without regard to specific land characteristics. All lands have the same probability of being sampled under this inventory system. The 1999 inventory used a computer-assisted classification of satellite imagery for classification. FIA used the imagery to form two initial strata—forest and nonforest. Pixels within 60 m (2 pixel widths) of a forest/nonforest edge formed two additional strata—forest/nonforest and nonforest/forest. Forest pixels within 60 m on the forest side of a forest-nonforest boundary were classified into a forest/nonforest stratum. Pixels within 60 m of the boundary on the nonforest side were classified into a nonforest/forest stratum.

In the 1990 inventory, aerial photographs were assembled into township mosaics, and a systematic grid of 121 one-acre photo plots (each plot representing 190.4 acres on the ground) was overlaid on each township mosaic. Each of these photo plots was stereoscopically examined by aerial photo interpretation specialists and classified based on land use, forest type, and stand-size density. From these photo plots, a systematic sample of plots (without regard to their aerial photo classification) was selected as ground plots and further examined by survey crews to verify the classification and to take further measurements. These 1990 ground plots formed the basis for the remeasured ground plots in the 1999 inventory. Additional information related to procedures for the 1990 inventory can be found in Miles *et al.* (1995).

The move to satellite imagery changed NCFIA's phase-one sample from being based on one photo plot every 190.4 acres to a sample based on a classified pixel every 0.22 acres. The increased intensity of the phase-one sample greatly improved the precision of estimates of the area within each stratum. Also, because classification was conducted using a computer-assisted algorithm across the entire State, biases in the photo plot sampling method that resulted from differences in photo quality, age of photography, and experience of the photo interpreter were eliminated and classification was consistent across the entire State.

Phase Two

Phase two of the inventory consisted of the measurement of an annual sample of field plots in Iowa. Current FIA precision standards for annual inventories require a sampling intensity of one plot for every 5,937 acres. To satisfy this requirement, the geographical hexagons established for the Forest Health Monitoring (FHM) program were divided into 27 smaller NCFIA hexagons, each of which contained 5,937 acres (McRoberts 1999). A grid of field plots was established by selecting one plot from each smaller hexagon based on the following rules: (1) if an FHM plot fell within a hexagon, it was selected as the grid plot; (2) if no FHM plot fell within a hexagon, the existing NCFIA plot from the 1990 inventory nearest the hexagon center was selected as the grid plot; and (3) if neither FHM nor existing NCFIA plots fell within the hexagon, a new NCFIA plot established at the hexagon center was selected as the grid plot (Hansen *et al.*, in prep.). This grid of plots is designated the Federal base sample and is considered an equal probability sample; its measurement in Iowa is funded by the Federal government.

The total Federal base sample of hexagonal grid plots was systematically divided into five interpenetrating, nonoverlapping subsamples or panels. Each year the plots in a single panel are measured with panels selected on a 5-year, rotating basis (Hansen *et al.*, in prep.). For estimation purposes, the measurement of each panel of plots may be considered an independent random sample of all land in a State. Field crews measured vegetation on plots in the forested and straddler (nonforest/forest and forest/nonforest) categories, and a sample of plots classified as nonforested were checked to ensure correct classification.

NCFIA has two categories of field plot measurements—phase-three plots (FHM plots) and phase-two field plots to optimize our ability to collect data when available for measurement. It is imperative that each type of plot be uniformly distributed both geographically and temporally. Phase-three plots are measured with the full array of FHM vegetative and health variables collected (Mangold 1998).

Phase-three plots must be measured between June 1 and August 30 to accommodate measurement of non-woody understory vegetation, ground cover, soils, and other variables. We anticipate that in Iowa the complete 5-year annual inventory will involve about 35 phase-three plots. On the remaining plots, only variables that can be measured throughout the entire year are collected. In Iowa, the complete 5-year annual inventory is expected to involve about 335 phase-two forested plots and about 215 phase-two straddler plots.

The new national FIA 4-point cluster plot design was used for data collection (fig. 6) in 1999 and will be used in subsequent years. The old NCFIA 10-point cluster plot design will be phased out over the next 5 years. For all remeasured field plots in the Federal base sample, the new 4-point cluster plot was established and measured at the old plot (1990) location. In addition, the first five subplots of the old 10-point (subplot) cluster plot were remeasured in 1999 to estimate change. All trees previously measured on these plots were remeasured or otherwise accounted for on these five subplots. These measurements form the basis for change estimates between the 1990 and current annual inventories for characteristics such as average annual net growth, mortality, and removals. Thus, until a complete cycle of annual inventories for Iowa has been accomplished, both the new 4-point cluster plots and part of the old 10-point cluster plots will be measured. If the anticipated 20 percent of the State is sampled each year, by the sixth year of annual inventories in Iowa, the new 4-point cluster plots will begin to be remeasured and the former plot design will be abandoned. The national plot design also requires mapping forest conditions on each plot. Due to the small sample size (20 percent) each year, precision associated with change factors such as mortality will be relatively low. Consequently, change estimates will not be reported until at least three annual inventories are completed, and even then we anticipate that estimates of change will be limited in detail. When the complete annual inventory has been implemented in 2004, estimates for the full range of change variables will be available.

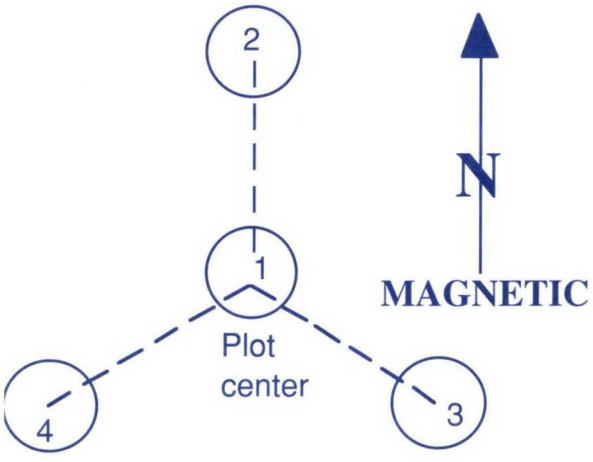


Figure 6.—*Current NCFIA field plot design.*

The overall plot layout for the new design consists of four subplots spaced 120 feet apart in a triangular arrangement. Subplots 2, 3, and 4 are spaced 120 degrees apart. The center of the new plot is located at the same point as the center of the previous plot if a previous plot existed within the sample unit. All trees less than 5 inches in diameter at breast height (d.b.h., or 4.5 feet above ground level) are measured on a 6.8-foot radius (1/300th acre) circular microplot located at the center of each of the four subplots. Trees with diameters 5 inches and larger are measured on a 24-foot-radius (1/24th acre) circular subplot. The forest condition of each subplot is recorded. Factors that can determine a change in condition from subplot 1 are changes in forest type, stand-size class, land use, ownership, and density. Each condition that occurs anywhere on one of the subplots is identified, described, and mapped if the condition in total meets or exceeds 1 acre in size (the 1 acre minimum size for a condition to be identified could include land off the subplot). Each condition is assigned a condition number and condition information is recorded.

Field plot measurements are combined with phase-one estimates in the compilation process and table production. The number of tables generated from a single year's data is limited; however, as additional annual inventories are completed, the number of tables will increase until year 5, when all statewide inventory summary tables will be available in both printed and electronic formats. If additional information is desired, requests may be directed to:

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St. Paul, MN 55108

or

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Iowa Department of Natural Resources
Division of Forests and Prairies
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Des Moines, IA 50319-0034
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